Determinação de características produtivas e a influência da assistência técnica no pagamento por qualidade do leite

Determination of productive characteristics and influence of technical assistance on milk quality payment

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RESUMO

A pecuária leiteira é uma das atividades mais representativas na agricultura familiar. A crescente exigência do mercado consumidor por produtos mais saudáveis e de melhor qualidade aumenta a necessidade de maior engajamento de pequenos produtores na produção de leite, proporcionando qualidade e lucratividade. Instruções Normativas (INs) foram instituídas pelo Ministério da Agricultura, Pecuária e Abastecimento (MAPA), objetivando a padronização da produção de leite. Um dos pilares para vencer os desafios da atividade é a transferência de conhecimentos e tecnologias pela assistência técnica rural. Sendo assim, os objetivos deste trabalho foram avaliar a qualidade do leite de tanque de refrigeração de pequenos produtores familiares antes e depois da assistência técnica, identificando as características de produção que influenciam na qualidade do leite e simulando o impacto dos programas de penalização na renda do produtor, para promover a melhoria da qualidade do leite. Vinte produtores leiteiros de agricultura familiar foram monitorados por dois anos. Analisaram-se os aspectos de qualidade do leite de tanque de resfriamento (composição, Contagem de Células Somáticas (CCS) e contagem padrão em placas (CPP)), e caracterização dos sistemas de produção por meio de questionários. Observou-se que o maior desafio para os produtores se adequarem as INs está relacionado à CPP e CCS. As condições higiênico-sanitárias e o conforto animal foram os fatores que mais influenciaram os índices de CPP. Apesar de não ter apresentado melhora significativa na qualidade do leite antes e depois da assistência técnica, é fundamental que o produtor receba orientações desses profissionais para garantir a consolidação e a manutenção do conhecimento de boas práticas de higiene e saúde do rebanho. Os índices de CCS, CPP e simulação de renda podem auxiliar a assistência técnica na conscientização dos produtores sobre a importância da adequação às INs, visando uma melhor qualidade do produto e aumento da renda familiar.

Palavras-chave: Agricultura familiar, higiene, mastite, transferência de tecnologia, rentabilidade, sustentabilidade.

ABSTRACT

Dairy farming is one of the most representative activities in family farming. The growing demand from the consumer market for healthier and better quality products increases the need for greater involvement of small producers in milk production, providing quality and profitability. Normative Instructions (INs) were established by the Ministry of Agriculture, Livestock and Supply (MAPA), aiming at standardizing milk production. One of the pillars to overcome the challenges of the activity is the transfer of knowledge and technologies through rural technical assistance. Therefore, the aims of this study were to evaluate the quality of refrigeration tank milk produced by small family farmers before and after technical assistance, identifying the production characteristics that influence milk quality and simulating the impact of penalty programs on the income of milk producers to promote the improvement of milk quality. Twenty family dairy farmers were monitored for two years. Refrigeration tank milk quality aspects were analyzed (composition, Somatic Cell Count (SCC) and standard plate count (SPC)), and characterization of production systems through the application of questionnaires. It was observed that the greatest challenge for producers to adapt to INs is related to the SPC and SCC. Hygienic-sanitary conditions and animal comfort were the factors that most influenced SPC indexes. Despite not having shown significant improvement in milk quality before and after technical assistance, it is essential that the producer receives guidance from these professionals to ensure the consolidation and maintenance of knowledge of good hygiene and health practices for the herd. SCC and SPC indexes and

income simulation can help technical assistance in raising awareness among producers about the importance of adapting to INs, aiming at better quality of the product and increase in family income.

Keywords: Family farming, hygiene, mastitis, technology transfer, profitability, sustainability.

1 INTRODUCTION

Family farming represents an important participation in Brazilian agribusiness. Of the 4.36 million family farmers in Brazil, about 1.171 million are milk producers, most of them small producers (IBGE, 2018). Many of these small producers have little or no technification and knowledge of good practices, thus producing low-quality milk with little industrial yield (RIBEIRO JÚNIOR, et al., 2013).

To ensure milk quality and safety, the Ministry of Agriculture, Livestock and Supply (MAPA) has prepared Normative Instructions (INs) with the aim of standardizing production, collection, transport and marketing processes. IN 76 and 77, of November 26, 2018, have set strict standards for raw milk production, including composition, somatic cell count (SCC) and standard plate count (SPC). All dairy farms must periodically monitor, through laboratory analyses, the quality of milk produced for possible identification of problems at its origin (BRASIL, 2018).

According to technical regulations, milk inspection must be carried out on the rural property, and not on the industry's reception platform. Thus, it is possible to identify and apply corrective measures, taking into account the bonus and penalty program (BRASIL, 2018). Quality-based milk payment is an incentive provided by the industry to dairy producers and directly influences raw milk quality, quantity and composition. However, to achieve the minimum standards required by legislation or to seek greater bonus within quality payment programs, it is important to guarantee producers access to knowledge of techniques and technologies. In this aspect, technical assistance can cooperate in the transfer of technologies, in order to improve the quality of the milk produced, in addition to contributing to the increase in herd productivity and family income (GONÇALVES et al., 2014).

Thus, the aims of this study were to evaluate the quality of refrigeration tank milk produced by small family farmers before and after technical assistance, identifying the production characteristics that influence milk quality and simulating the impact of penalty programs on the income of milk producers to promote the improvement of milk quality.

2 MATERIAL AND METHODS

Ethics Committee: This study is exempt from the ethics committee for not handling animals.

Twenty family dairy properties located in the region of Piracicaba, SP, Brazil participated in the study. Properties had average of 29.4 hectares, 53 animals with average of 19 lactating cows and daily production of 207 liters of milk, with more than 50% of the family income coming from the dairy activity.

Data were collected from October 2016 to March 2017 and from October 2017 to March 2018.

Technical assistance: Technical assistance was carried out by extension agents from the Integrated Technical Assistance Coordination (CATI), who were previously trained by Animal Science Institute specialists (IZ). From April 2017 to March 2018, rural properties received a monthly report containing results of milk analyses performed in each property, as well as information and technical recommendations on nutritional management, hygiene and health, with the purpose of improving milk quality.

Questionnaire on the characteristics of properties: All milk producers participating in the study completed the questionnaire with the help of CATI extension agents in January 2017, to characterize each property. The questionnaire was prepared by the team and consisted of questions related to three themes: 1) structure of milking facilities, as well as maintenance and hygiene of the place and materials used; 2) milk storage and transport and water quality (origin of water used in milking, storage and treatments to which it was submitted); 3) human resources, describing the hygiene processes carried out by employees and those responsible for the milking process.

Determination of milk composition, SCC and SPC: Milk samples from refrigeration tanks were collected by a properly trained person in charge of transporting milk to the cooperative. After homogenization for 5 to 10 minutes, 40 mL of milk from each refrigeration tank were collected in flask containing Bronopol® preservative to determine SCC and composition, and another 40 mL were packed in sterile flask containing Azidiol® preservative to determine SPC. Then, samples were placed in isothermal boxes containing recyclable ice, kept under refrigeration at 4 °C for up to three days and sent to the 'Clinica de Leite' Laboratory (ESALQ/USP).

Milk composition (fat, protein and defatted dry extract [DDE]) was determined by infrared absorption using the MilkoScan FT+ device (FOSS North America, EdenPraire, MN, USA). SCC and SPC were analyzed by flow cytometry using the

Fossomatic FC (FOSS A/S Hillerod, Denmark) and BactoScan FC (FOSS A/S Hillerod, Denmark) devices, respectively.

Statistical analysis: To determine milk quality, milk composition parameters, SCC and SPC were used. Due to the wide dispersion of SPC and SCC values, logarithmic transformation was used for SPC (log SPC = log10 (SPC)) and for CCS, transforming it into somatic cell scores (SCS), according to formula proposed by Shook (1982):
SCS = log2 (SCC/100) + 3.

The average results for the two periods under study were compared by analysis of variance using the PROC GLM of SAS 9.3 software.

Data referring to the producers' responses were organized and submitted to principal component analysis using the multivariate analysis module of the SAS (2003) software. These analyses were performed to establish possible relationships between the ease of improving SPC and the other variables present in questionnaires.

Regarding the milk quality payment program, price information according to Dairy Partners Americas - Brazil (DPA, 2019) was used as bonus and penalty reference (Table 1). The average daily production of properties evaluated for the two periods under study was calculated. From this average, the average daily and annual bonus and penalty was calculated according to milk quality results.

Table 1. Milk quality payment program (bonus and penalty) according to Dairy Partners Americas - Brazil (DPA, 2019).

Components	Values	R$/liter
Protein (%)	2 - 2.09	-0.1017
	2.9 - 3.09	0
	>3.70	+0.1
Fat (%)	2 - 2.09	-0.052
	3 - 3.29	0
	4.3 - 5.0	+0.036
SPC (CFU x 1000/mL)	1 – 100	+0.03
	101 – 200	0
	>201	-0.03
SCC (SC x 1000/mL)	201 - 400	+0.04
	401 – 500	-0.01
	>501	-0.03

SPC: Standard Plate Count.
SCC: Somatic Cell Count.

3 RESULTS

From the mean values of the physicochemical and microbiological milk composition, no significant change in milk quality between the periods evaluated in the present study was observed (Table 2). The mean milk composition and SCC values were

within limits established by IN 76 (BRASIL, 2018). However, SPC was above the determined value of 300,000 CFU/mL, indicating deficiencies in the hygienic-sanitary conditions.

Table 2. Average values of the physicochemical and microbiological milk composition of rural properties.

Variables	Oct/16 – Mar/17	Oct/17 – Mar/18	*P**	CV (%)
Fat (%)	3.29 ± 0.20	3.36 ± 0.27	0.1599	15.28
Protein (%)	3.10 ± 0.10	3.13 ± 0.13	0.1163	7.55
Defatted dry extract (%)	8.53 ± 0.11	8.44 ± 0.24	0.2073	4.76
Somatic Cell Count (SC/mL)	471 ± 227	406 ± 157	-	-
Somatic Cell Score (SCS)	4.79 ± 0.61	4.59 ± 0.53	0.2364	23.88
Standard Plate Count (CFU/mL)	355 ± 552	306 ± 1012	-	-
Log SPC	2.55 ± 0.40	2.49 ± 0.46	0.1077	30.87

When the percentage of samples that would be rejected by IN 76 (BRASIL, 2018) was analyzed, it was observed that the greatest obstacle for producers regarding milk quality was related to SPC, with rejection rate of 53% before assistance technique and 48% after. In turn, SCC had rejection rate of 39% before technical assistance and 35% after (Table 3).

Table 3. Percentage of rejected refrigerated raw milk samples, according to standards established by IN 76/2018 in the experimental periods.

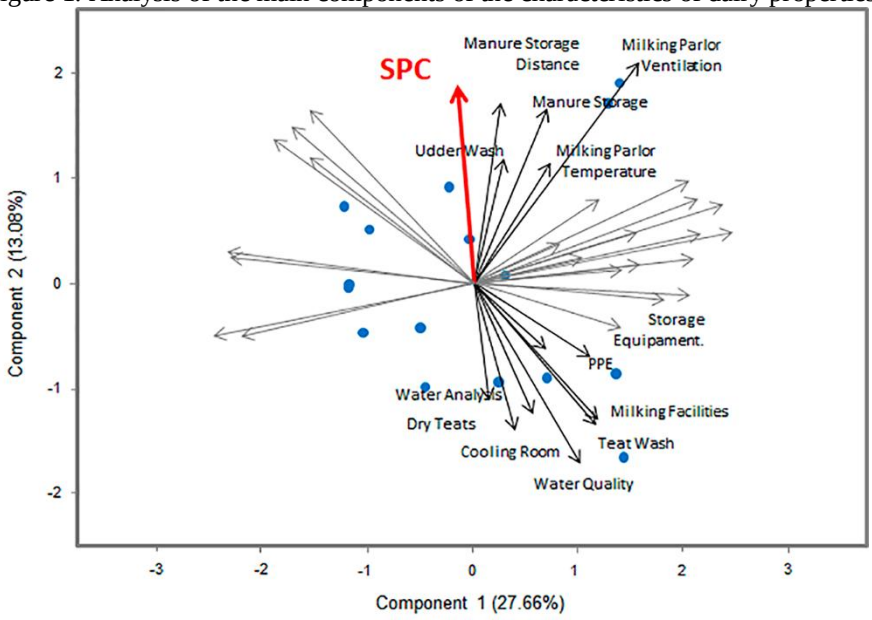
Variables	Oct/16 – Mar/17	Oct/17 – Mar/18
Fat	27%	25%
Protein	17%	17%
Defatted dry extract	28%	30%
Somatic Cell Count	39%	35%
Standard Plate Count	53%	48%

Thus, from results of the questionnaire on the characteristics of properties, it was possible to identify the parameters that hypothetically interfered with SPC (Figure 1). To better understand the effect of technical assistance, producers were classified into two groups: those who reduced SPC rates, and those who had no effect or increased SPC values over the experimental period.

The criteria identified and correlated with the group that showed reduction in SPC were: use of personal protective equipment (PPE); milking routine; washing and drying of udders; place reserved for the milk refrigeration tank; use of proper products for cleaning the tank and milking equipment; location and storage conditions for milking utensils; existence and distancing of manure pits; good temperature and ventilation conditions in the milking room and good origin of water used for washing. Parameters related to the group that showed maintenance or increased SPC were failure to wash the

udder before starting milking, lack of a place reserved for the refrigeration tank, presence of manure pits near the milking place, high temperature and absence of ventilation in the milking room, in addition to poor water quality.

Figure 1. Analysis of the main components of the characteristics of dairy properties.



Milk quality can positively or negatively impact producers' income. Thus, bonus and penalty were simulated and how much the quality of milk produced in evaluated properties had an impact on the amount that would be paid to producers was demonstrated (Table 4).

According to this simulation, technical assistance helped to reduce the average annual penalty of R$ 682,55. This shows that technical assistance can significantly contribute to milk quality, and consequently, increase the quality bonus payment.

Table 4. Simulation of payment to producers (with average data from the study), according to the milk quality payment program (bonus and penalty) of the Dairy Partners Americas - Brazil (DPA, 2019).

	Oct/16 – Mar/17		Oct/17 – Mar/18	
	Payment simulation (R$)		Payment simulation (R$)	
Fat	3.29	0	3.36	0.008
Protein	3.10	+0.015	3.13	+0.018
SCC	>471	-0.01	>406	-0.01
SPC	>355	-0.04	>306	-0.04
Penalty simulation				
R$/liter		-0,035		-0,024
R$/day[1]		-5,95		-4,08
R$/year		**-2.171,75**		**-1.489,20**

[1] Considering the production of 170 liters/day of milk per producer.
SPC: Standard Plate Count.
SCC: Somatic Cell Count.

In addition, if the maximum bonus classes for SCC between 201 and 400 SC/mL (+0.04 R$/L), and SPC between 51 to 100 UFC/mL (+0.03 R$/L) was taken into account, producers could receive an average annual bonus of up to R$ 4,343.50 (Table 5).

Table 5. Bonus payment simulation for milk quality by SCC and SPC, considering the production of 170 liters/day.

Bonus	**Quality parameters**	
	SCC[1]	**SPC[2]**
R$/L	0,04	0,03
R$/day[3]	6,80	5,10
R$/year	2.482,00	1.861,50
Total annual bonus (R$)	**4.343,50**	

[1] Considering SCC bonus between 201 and 400 SC/mL.
[2] Considering SPC bonus between 51 and 100 CFU/mL.
[3] Considering the production of 170 liters/day of milk per producer.

4 DISCUSSION

The production of quality milk is linked to several factors such as hygiene during the milking process, storage temperature and milk transport, animal breed, nutritional management, lactation stage, animal welfare and health problems in the herd, such as mastitis (MACEDO et al., 2018; SILVA et al., 2011).

INs establish minimum quality standards for raw milk commercialization (BRASIL, 2018). However, many producers face difficulties in adapting to these minimum standards. In this work, the greatest obstacles found by evaluated properties are related to high SPC, followed by SCC (Table 2 and 3). These results corroborate data published in 2015 by the 'Clinica de Leite' Laboratory /ESALQ/USP, in which 35% and 28% of the 44 thousand herds analyzed had SPC and SCC values, respectively, above limits established by IN 62, in force in time (CASSOLI et al., 2016; CASSOLI; MACHADO, 2016).

In addition, when the characteristics of properties and their relationship with SPC were studied, it was evident that properties that managed to achieve lower SPC levels were those that applied good hygiene practices throughout the milking process, which were concerned with the quality of water used and with milk storage (appropriate temperature and location), in addition to animal welfare (Figure 1).

SPC is indicative of the hygiene conditions during the milking process and maintenance of temperature in the milk refrigeration tank (PARAFFIN; ZINDOVE; CHIMONYO, 2018). On the other hand, SCC has been used worldwide as a standard indicator of mastitis in the herd: increase in somatic cells is mainly due to intramammary

infections, and its evolution is directly linked to the inflammatory process (MARTIN et al., 2018).

Microbial contamination can occur by endogenous and exogenous routes, depending on the current hygiene conditions. However, from the technological point of view, the most relevant microorganisms are those that contaminate milk during and after milking (MENEZES et al., 2014). Generally, high bacterial counts are quickly corrected with changes in hygiene protocols, and SCC requires effective mastitis control programs in the herd (SANTOS; FONSECA, 2019).

The use of good practices is essential to ensure food safety, animal welfare and health (SILVA et al., 2019). The use of disinfectant solutions in pre- and post-dipping, the use of disposable paper towels for drying udders, washing the milking equipment with its own solutions, cleaning the milking room, as well as the animal's facilities, are measures that reduce the risks of microbial milk contamination, in addition to intramammary infections (AL- HUBAETY, 2013; POLÓ; ANJOS; SILVA, 2021).

In addition, other parameters that guarantee milk quality and safety are the proper storage location and immediate refrigeration of raw milk to 4 °C, since refrigeration reduces the multiplication rate of contaminating microbiota (MENEZES et al., 2014). The quality of the water used must also be considered, as it is used in the cleaning and sanitizing of milking and refrigeration equipment and utensils, and is therefore a potential source of contamination and transmission of microorganisms (ORWA; MATOFARI; MULIRO, 2017).

Another important aspect regarding milk quality is the human factor. Often the failure of milk quality improvement programs is related to human behavior and attitudes, since good practices must be incorporated into the dairy farm's routine and depend on behavioral changes (VAN DEN BORNE et al., 2014). In a study of 336 Dutch farms, Jansen et al. (2009) showed that up to 48% of variation in SCC of the refrigeration tank was mainly related to human attitudes, that is, knowledge, beliefs, values, objectives and intentions, also considering the behavior of farmers in relation to mastitis.

For the producer to improve the herd production, it is important that there is a change in behavior. To do so, the producer must have, in addition to knowledge and skills, motivation, as is the case of penalties or bonuses from the dairy industry for the quality of milk produced (FREITAS et al., 2018).

In this study, how milk quality and technical assistance influence the profitability of evaluated properties was demonstrated through simulation of bonuses or penalties.

According to the average values found, farmers would be penalized for the quality of the milk produced (Table 4). However, if these producers adopted the good practices that contribute to reduce SCC and SPC, they could receive a quality bonus, and consequently, increase their average annual income by up to R$ 4,343.50, according to the simulation performed (Table 5). For Billikopf (2005), the greatest incentive for producers to improve quality indexes is through the visualization of profits by adopting these practices. Economic indicators have great influence on the performance of the activity and are essential to help obtaining more efficient production. The survey of indexes that measure the efficiency of production systems and indicate errors being made is important in the technical and careful analysis of points that must be changed.

The points to be changed are the principle of technical assistance actions. This can contribute to improving milk quality with consequent increase in bonuses through the transfer of knowledge and technologies. Technical assistance plays only the role of technically and judiciously recommending actions aimed at improving production. However, it is up to the producer to spontaneously decide whether or not to comply with these recommendations. In this study, although the technical assistance service was not statistically significant regarding quality values, reduction in penalty values was observed after assistance (Table 4). It is worth emphasizing the importance of periodic training programs and support to producers by qualified technical assistance for better understanding and mitigation of the various risks in dairy production. Raw milk quality is directly linked to the health of animals, attention and daily care with hygiene (BERGE; BAARS, 2020).

Extension agents play a key role in influencing farmer behavior. Periodic technical follow-up helps rural producers to adapt to production and marketing standards for agricultural and livestock products, in addition to helping to increase productivity (BORGES; GUEDES; CASTRO, 2016). According to the Agricultural Census carried out between 2006 and 2017, there was a growth in the dairy farming productivity by 62%. In addition, production increased from 1.6 thousand liters per cow to 2.6 thousand liters/cow/year (IBGE, 2018). According to Rocha and Carvalho (2020), these results are related to the improvement of rural management, animal breeding programs and the adoption of technologies through specialized technical assistance.

Scientific evidence demonstrates the importance of training and rural extension in changing attitudes towards herd management practices by farmers. In studies conducted on Irish herds by Dillon; Hennessy and Cullinan (2016), it was shown that education,

rural extension and milk production monitoring significantly improved the health of the herd, with overall average SCC reduction of 25%. In addition, producers who received technical assistance and who participated in discussion groups on management and quality were seven times more likely of practicing milk production monitoring. The acceptance of agricultural training and herd management practices, linked to extension services, are positively related to SCC reduction and consequently improvement in the health of the herd and quality of the milk produced.

In short, the decrease in SPC and SCC is linked to good management practices and periodic technical monitoring and technology transfer by rural technical assistance. SCC, SPC and bonus/penalty indexes can contribute to technical assistance in raising the awareness of producers to adapt to the norms established by INs, aiming at better quality of the final product and increase in family income.

5 CONCLUSION

The effect of technical assistance on the improvement of milk quality was not observed. However, for the conditions of this study, reduction in the percentage of samples rejected by limits established by the IN was observed. Since the greatest challenge faced by producers demonstrated a relationship with SPC, the use of good practices in milking, cleaning and maintenance of facilities must be present in the technical assistance recommendations for greater service effectiveness and, consequently, to improve production profitability through milk quality payment programs.

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